

## TITLE OF THE INVENTION

### DRUM WASHING MACHINE AND METHOD OF CONTROLLING THE SAME

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims the benefit of Korean Patent Application No. 2003-53159, filed July 31, 2003 in the Korean Intellectual Property Office, the disclosures of which are incorporated herein by reference.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

**[0002]** The present invention relates, in general, to drum washing machines and, more particularly, to a drum washing machine and method of controlling the drum washing machine, which improves washing performance by increasing solubility of a powdered detergent.

### 2. Description of the Related Art

**[0003]** Generally, a drum washing machine is a device that washes laundry using a drop generated by a rotation of a rotary tub having a drum shape.

**[0004]** In a conventional drum washing machine, a washing process is executed after a detergent is fed into a rotary tub at the same time that a set amount of water is fed.

**[0005]** Further, during an opposite directional rotation of the rotary tub, the fed detergent dissolves in the water and separates stains from laundry.

**[0006]** However, in the conventional drum washing machine, the fed detergent sinks to a bottom of a water tub which is fixed, and dissolves in the fed water during the opposite directional rotation of the rotary tub. In this case, sufficiently dissolving the detergent in the water using only the opposite directional rotation of the rotary tub is difficult. As a result, detergent deposits remain in the water and, therefore, the laundry may not be washed clean. Additionally, a long time is required to sufficiently dissolve the detergent in the water, thus increasing a washing time in proportion to the time required for the sufficient dissolution of the detergent.

**[0007]** Further, in the conventional drum washing machine, detergent solution, in which the detergent dissolves in water, gradually disperses to an upper part of laundry from a lower part thereof by the opposite directional rotation of the rotary tub. Therefore, it may take a relatively long time for the detergent solution to disperse to the upper part of the laundry from the lower part thereof according to materials of the laundry, or the detergent solution may not sufficiently soak through the laundry, thus increasing a washing time and deteriorating washing performance.

#### SUMMARY OF THE INVENTION

**[0008]** Accordingly, an aspect of the present invention provides a drum washing machine and method of controlling the drum washing machine, which increases solubility of a powdered detergent by sufficiently dissolving the powdered detergent in water, thus shortening a washing time and improving washing performance.

**[0009]** Another aspect of the present invention provides a drum washing machine and method of controlling the drum washing machine, which uniformly disperses a detergent solution, in which a powdered detergent dissolves in water, over laundry, thus improving washing performance and shortening a washing time.

**[0010]** The above and/or other aspects are achieved by providing a drum washing machine including a water tub, a rotary tub rotatably provided in the water tub, and a detergent dissolving unit provided outside of the water tub and provided with a first end connected to an inside of the water tub, the detergent dissolving unit dissolving a detergent contained in a lower portion of the water tub in water contained in the lower portion.

**[0011]** The detergent dissolving unit may include a detergent dissolution pipe provided with a first end connected with the inside of the water tub and a second end extended outside of the water tub, a pump to pump the water and the detergent contained in the lower portion of the water tub to the detergent dissolution pipe, and a control unit to operate the pump according to preset ON/OFF periods to reciprocate the water and the detergent contained in the lower portion of the water tub between the water tub and the detergent dissolution pipe.

**[0012]** The detergent dissolving unit may further include a detergent dissolution space formed at the detergent dissolution pipe, the detergent dissolution space having a diameter greater than that of the detergent dissolution pipe.

**[0013]** The second end of the detergent dissolution pipe may be provided at an inlet of the rotary tub.

**[0014]** The detergent dissolving unit may further include a spray nozzle provided at the second end of the detergent dissolution pipe.

**[0015]** The detergent dissolving unit may further include a valve mounted at the detergent dissolution pipe to selectively open and close a flow passage.

**[0016]** The above and/or other aspects are achieved by providing a method of controlling a drum washing machine, the drum washing machine having a water tub, a rotary tub, and a detergent dissolving unit provided outside of the water tub, the method including feeding water and a detergent into the water tub, and reciprocating the detergent between the water tub and the detergent dissolving unit to dissolve the detergent.

**[0017]** The drum washing machine control method may further include rotating the rotary tub, and feeding a detergent solution, in which the detergent dissolves in water by the reciprocation, into the rotary tub while the rotary tub is rotated.

**[0018]** The drum washing machine control method may further include spraying and feeding a certain amount of water into the rotary tub after feeding the detergent solution into the rotary tub.

**[0019]** The drum washing machine control method may further include rotating the rotary tub in opposite directions at a low speed after completely feeding the detergent solution.

**[0020]** Additional and/or other aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0021]** These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a perspective view showing an internal structure of a drum washing machine, according to an embodiment of the present invention;

FIG. 2 is a control flowchart of a method of controlling the drum washing machine, according to an embodiment of the present invention;

FIGS. 3A and 3B are views showing a process of dissolving a detergent;

FIG. 4 is a view showing a process of spraying and feeding clean water into a rotary tub while rotating the rotary tub at a high speed before spraying a detergent solution; and

FIG. 5 is a view showing a process of spraying the detergent solution into the rotary tub.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0022]** Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below to explain the present invention by referring to the figures.

**[0023]** FIG. 1 is a perspective view showing an internal structure of a drum washing machine, according to an embodiment of the present invention. As shown in FIG. 1, in the drum washing machine of the present invention, first and second water feed pipes 12 and 13 are provided to allow water flowing from an external water supply pipe to selectively flow into a water tub 10 or a rotary tub 11.

**[0024]** The first water feed pipe 12, which is one of the water feed pipes, is connected to the water tub 10, and the second water feed pipe 13, which is a remaining one, is connected to an inside of the rotary tub 11. The first and second water feed pipes 12 and 13 include first and second water feed valves 14 and 15 respectively mounted thereat to allow water to selectively flow into the water tub 10 or the rotary tub 11.

**[0025]** At the first water feed pipe 12, a detergent container 16 is disposed between the first water feed valve 14 and the water tub 10 to feed both water and detergent into the water tub 10.

**[0026]** Further, a spray nozzle 13a is provided at an end of the second water feed pipe 13 to spray water into the rotary tub 11. Therefore, the drum washing machine is constructed so that both water and detergent are fed into the water tub 10 through the first water feed pipe 12 and only water is sprayed and fed into the water tub 10 through the second water feed pipe 13.

**[0027]** A drain pipe 17 is mounted on a bottom of the water tub 10 that contains water and detergent flowing into the water tub 10 through the first water feed pipe 12. A drain pump 18 and a drain valve 19 are mounted at the drain pipe 17 to pump the water and the detergent contained in a lower portion of the water tub 10.

**[0028]** On the drain pipe 17, a detergent dissolution pipe 20 branched from the drain pipe 17 is disposed between the drain pump 18 and the drain valve 19. One end of the detergent dissolution pipe 20 is connected to the drain pipe 17 connected to the inside of the water tub 10, and a remaining end thereof is connected to an inlet of the rotary tub 11. Further, a spray nozzle 20a is formed at the remaining end of the detergent dissolution pipe 20 to spray a detergent solution into the rotary tub 11. A cylindrical detergent dissolution space 20b with a diameter greater than that of the detergent dissolution pipe 20 is formed at a center portion of the detergent dissolution pipe 20. Further, a detergent dissolution pipe valve 21 is provided at the detergent dissolution pipe 20 to prevent water from flowing into the detergent dissolution pipe 20 when draining.

**[0029]** Moreover, a reversible motor (not shown) is mounted in the rotary tub 11, so that the rotary tub 11 is rotated in forward and reverse directions. Further, although not shown in FIG. 1, a water level sensor is mounted in the rotary tub 11 to sense a level of water contained in the rotary tub 11.

**[0030]** The first and second water feed valves 14 and 15, the motor, the drain pump 18, the drain valve 19 and the detergent dissolution pipe valve 21 are electrically connected to a control unit that performs an entire control operation.

**[0031]** Hereinafter, a method of controlling the drum washing machine of the present invention is described through a detailed operating process of the drum washing machine.

**[0032]** FIG. 2 is a control flowchart of a method of controlling the drum washing machine, according to an embodiment of the present invention. Referring to FIG. 2, the first water feed

valve 14 is turned on for a certain period of time to allow water and detergent to be fed into the water tub 10 in operation 100.

**[0033]** Accordingly, as briefly described above, the detergent and the water are contained in a lower portion of the water tub 10. However, since the water flowing from the water supply pipe has run over the detergent in the detergent container 16, the detergent may not sufficiently dissolve in the water. Therefore, a considerable amount of detergent may remain in the solid state in the water. Further, as will be described later, even though the rotary tub 11 is rotated in opposite directions after a set amount of water is fed at this time, and a detergent solution is able to rapidly soak through a lower part of laundry, which comes into contact with an inner wall of the rotary tub 11, a relatively long time is required for the detergent solution to sufficiently soak through a center part of the laundry.

**[0034]** Therefore, to solve the problems noted above, a detergent dissolving process, which sufficiently dissolves the detergent in the water, is required. Additionally, a detergent spraying process, which directly sprays the detergent solution, in which the detergent sufficiently dissolves in water, into the rotary tub, is also required.

**[0035]** The detergent dissolving process is executed so that the drain pump 18 is operated according to preset ON/OFF periods to perform detergent dissolution, thus repeating operations illustrated in FIGS. 3A and 3B in operation 110. Accordingly, the detergent in the lower portion of the water tub 10 dissolves in the water in the lower portion thereof. To increase the dissolution of the detergent in the water, the detergent and the water are forced to reciprocate between the water tub 10 and the detergent dissolution pipe 20. Thus, the water and the detergent are shaken and mixed.

**[0036]** That is, during the ON period of the drain pump 18, the water and the detergent contained in the lower portion of the water tub 10 are pumped into the detergent dissolution space 20b of the detergent dissolution pipe 20, as shown in FIG. 3B. On the contrary, during the OFF period of the drain pump 18, the water and the detergent contained in the detergent dissolution pipe 20 are moved again to the lower portion of the water tub 10, as shown in FIG. 3A. At this time, the ON period of the drain pump 18 is preset to such an extent that the water contained in the detergent dissolution pipe 20 is prevented from overflowing the detergent

dissolution space 20b and then flowing into the rotary tub 11. Therefore, the solubility of the detergent may be increased due to a shaking and mixing action.

**[0037]** After the detergent dissolving process is executed, the first water feed valve 14 is turned on to feed a preset amount of water in operation 120. Therefore, water flowing from the water supply pipe is fed into the water tub 10 through the first water feed pipe 12, and gradually fills the rotary tub 11.

**[0038]** Further, to uniformly soak the laundry in water, the motor used to drive the rotary tub is rotated in forward and reverse directions at a preset speed, thus rotating the rotary tub 11 in opposite directions at a low speed in operation 130.

**[0039]** Thereafter, the rotary tub 11 is rotated at a high speed. As a result, centrifugal force causes the laundry to come into contact with the inner wall of the rotary tub 11, thus forming a cavity around a center of the rotary tub 11 in operation 140. During operation 140, a rotation speed of the motor is higher than that of the motor at the time of washing. A rotating direction of the motor is preset according to a mounting position of the detergent solution spray nozzle 20a to efficiently spray the detergent solution on the upper part of the laundry. For example, a spraying direction of the detergent solution spray nozzle 20a and the rotating direction of the rotary tub 11 are set to correspond to each other. If the detergent solution spray nozzle 20a is mounted to face a left portion of the rotary tub 11 at a right portion of the rotary tub 11, the rotary tub 11 is rotated counterclockwise.

**[0040]** After the rotary tub 11 is rotated at a high speed to form the cavity in operation 140, the second water feed valve 15 is turned on again, thus spraying and feeding a certain amount of water (1 to 2 liter) on the upper part of the laundry, as shown in FIG. 4, in operation 150. A reason for the above operation is to prevent stains from being generated on the laundry at the time of spraying the detergent solution because the upper part of the laundry is not sufficiently soaked with water compared to the lower part of the laundry coming into contact with the inner wall of the rotary tub 11. Additionally, since a weight of the laundry is increased due to the spraying and feeding of the water, and the rotary tub 11 is rotated at a high speed, a size of the cavity is increased depending on the increased weight of the laundry.

**[0041]** After a predetermined amount of clean water is sprayed, and thereby fed, into the rotary tub 11, the drain pump 18 is turned on for the ON period while the rotary tub 11 is rotated

at a high speed, thus spraying the detergent solution contained in the detergent dissolution space 20b on the upper part of the laundry within the rotary tub 11 for a certain period of time (for example, 1 minute), as shown in FIG. 5, in operation 160. Accordingly, the detergent solution sufficiently soaks through the upper part of the laundry, so that the detergent solution is absorbed into the laundry in a short time. Therefore, a washing time is shortened and utilization of the detergent is increased, thus improving washing performance.

**[0042]** Meanwhile, a later washing process may be executed while the laundry masses and entangles as the rotary tub 11 is rotated at a high speed in operation 160. Therefore, the rotary tub 11 is rotated in opposite directions at a low speed, thus forming a water current to disentangle the laundry in operation 170. Accordingly, after the massed or entangled laundry is released thereby reducing wrinkles in the laundry a washing process is executed.

**[0043]** In the above control flowchart, a case where the water feeding process is executed after the detergent dissolving process is described as an embodiment. However, the present invention is not limited to the above embodiment, and the detergent dissolving process and the water feeding process may be simultaneously executed.

**[0044]** As apparent from the above description, the present invention provides a drum washing machine and method of controlling the drum washing machine, which increases the solubility of a powdered detergent by sufficiently dissolving the powdered detergent in water, thus decreasing a washing time and washing laundry more cleanly.

**[0045]** Further, the present invention is advantageous in that a detergent solution sufficiently soaks through an upper part of laundry as well as a lower part thereof, thus increasing the utilization of a detergent and consequently improving washing performance.

**[0046]** Further, the present invention is advantageous in that a detergent solution is sprayed on laundry after a rotary tub is rotated at a high speed to bring the laundry into contact with an inner wall of the rotary tub and, thus, a cavity is formed, thus efficiently spraying the detergent solution on the upper part of the laundry.

**[0047]** Moreover, the present invention is advantageous in that a detergent solution is sprayed on laundry after the laundry is sufficiently soaked with water, thereby preventing the laundry from being stained with the detergent solution.



**[0048]** Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.